# TOXIC GASEOUS SUBSTANCES LIBERATED FROM URINE DURING STORAGE

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The urine stored in special containers on board the spacecraft may be a potential source of pollution of the cabin atmosphere by certain toxic and foul-smelling substances. The composition and volume of urine excreted by the healthy human subject varies within wide limits depending on the character and quantity of the food and liquids consumed. The mean volume of urine produced in 24 hours is 1000-1600 ml [1, 2]. Urine consists of about 95% water, the remaining 5% being accounted for by various substances, especially urea, creatinine, phenols, uric, hippuric and oxalic acids, purine bases, ammonia and other compounds. Only a few of these substances composing urine are volatile and potentially harmful to man [3-5]. The principal members of this class are ammonia, certain amines, phenols and organic thio-acids. However, in the accessible literature we could find no information on the quantity of toxic substances possibly liberated into the atmosphere from fresh urine and from urine during storage. The present investigation was carried out to study these problems. Two series of experiments were performed. In the experiments of series I the liberation of toxic substances from fresh urine was studied. /432

Urine in a volume of 200 ml was poured into a glass bottle and atmospheric air bubbled through it. The bottle was incubated at 38°C. The air bubbled through the urine was first purified in a system of columns containing hopcalite, pumice soaked in sulfuric acid, silica gel, and granulated alkali. After the bottle, absorbents were included for trapping the toxic substances for subsequent determination. Samples of air for determination of carbon monoxide and hydrocarbons were drawn off into glass gas pipets. The rate of bubbling of the air was chosen so as to ensure completeness of absorption (1.5 liters/min) of the toxic pollutants in the absorbent solutions. The air was bubbled through for 3 h. /433

To determine toxic substances liberated from the urine the following chemical methods were used. Acetone, mercaptans, oxides of nitrogen, hydrocarbons, carbon monoxide and fatty acids were determined by methods developed at the Erisman Institute of Hygiene and Sanitation [1, 6]. Phenols were determined by a method based on the reaction of phenols with amidopyrin (M.F. Obukhova). Ammonia together with aliphatic amines was determined by iodometric titration. /434

The quantities of toxic substances were calculated per 100 ml urine. The results of this series of experiments are given in Table 1.

The results in Table 1 show that considerable amounts of phenols, ammonia and aliphatic amines, carbon monoxide and hydrocarbons are liberated from fresh urine when pure air is bubbled through it. Mercaptans and hydrogen sulfide were found in trace amounts in only 5 of 11 samples.

TABLE 1. Liberation of Toxic Substances from Fresh Urine

| Quantity of toxic substances, mg/100 ml urine | | | | | | |
|---|---|---|---|---|---|---|
| Ammonia and aliphatic amines | Phenols | Mercaptans and hydrogen sulfide | Acetone | Fatty acids | Carbon monoxide | Hycarbons calculated as methane |
| 0,069 | 0,014 | — | — | — | 0,068 | 0,017 |
| 0,023 | 0,012 | — | — | — | 0,140 | 0,038 |
| — | 0,029 | Traces | — | — | 0,015 | 0,055 |
| 0,014 | 0,041 | » | 0,032 | — | 0,076 | 0,083 |
| 0,002 | 0,026 | » | 0,009 | — | — | 0,031 |
| 0,007 | 0,045 | » | 0,029 | — | 0,046 | 0,038 |
| 0.004 | 0,033 | » | 0,008 | — | 0,070 | 0,010 |
| Traces | 0,013 | — | Traces | 0,033 | 0,094 | 0,021 |
| » | 0,017 | — | 0,003 | — | 0,039 | — |
| » | 0,013 | — | Traces | Traces | 0,006 | — |
| » | 0,016 | — | Traces | » | 0,003 | — |
| Mean 0,012 | 0,024 | — | 0,010 | — | 0,055 | 0,033 |

*Content of substances in mg/liter air bubbled through. Commas represent decimal points.

TABLE 2. Liberation of Toxic Substances from Urine Kept for 3 Days in a Closed Container

| Quantity of toxic substances, mg/100 ml urine | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ammonia and aliphatic amines | Phenols | Mercaptans and hydrogen sulfide | Acetone | Fatty acids | Carbon monoxide | Hycarbons calculated as methane | Oxides of nitrogen calculated as $N_2O_5$ |
| Traces | 0,006 | Traces | — | — | 0,026 | 0,049 | 0 |
| 0,001 | 0,007 | » | Traces | 0,058 | 0,028 | 0 | 0 |
| 0,005 | 0,008 | » | 0,002 | 0,028 | 0,017 | 0,034 | 0,003 |
| Traces | 0,007 | — | Traces | 0,012 | 0,036 | 0,149 | Traces |
| 0,001 | 0,006 | — | » | 0,012 | 0,039 | 0 | » |
| 0,094 | 0,005 | — | 0,0004 | 0,020 | 0,071 | 0,085 | 0,0005 |
| Traces | 0,006 | — | 0,0008 | 0,035 | — | 0,151 | 0,0003 |
| Mean 0,014 | 0,006 | — | 0,0006 | 0,028 | 0,035 | 0,094 | 0,0013 |

*Content of substances in mg/liter air bubbled through. Commas represent decimal points.

In the experiments of series II an attempt was made to determine the changes in the composition and quantity of toxic substances liberated from urine when kept for 3 days at a temperature of 18-20°. Urine in a volume of 500 ml was kept in hermetically sealed 5-liter glass bottles for three days. Next, samples of air were withdrawn from the bottles through a system of vessels with absorbent solutions and into gas pipets. The results of these experiments are given in Table 2.

As Table 2 shows, the air above the urine stored for 3 days is contaminated by several toxic products. In these experiments the same substances were found as in those of series I. In addition, oxides of nitrogen were found in the air samples. Comparison of the results of the experiments of series I and II shows that the mean content of ammonia and aliphatic amines was practically the same in both cases. Liberation of phenols and acetone from urine during keeping was significantly less than when pure air was bubbled through fresh urine. Much larger quantities of fatty acids are liberated from urine stored for 3 days than from fresh urine. /435

## REFERENCES


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